IS IT WORTH IT?

The energy side of recycling aluminum cans

Missouri Department of Natural Resources

GRADE LEVEL:
Upper Middle School/High School

SUBJECT AREA:
Sciences, Math

DURATION:
Preparation time: 15 minutes
Activity time: one to two 50-minute class sessions

SETTING:
Classroom

SKILLS:
Application, Analysis, Synthesis, Evaluation

KEY WORDS:
Aluminum, Recycle, Calibration

CORRELATIONS TO SHOW-ME STANDARDS:

Performance Standards
1.1, 1.2, 1.3, 1.6, 1.8, 1.10, 3.1, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8. 4.1, 4.6, 4.7

Knowledge Standards
SC-1,5,7,8
M-1

SUMMARY

This exercise is designed to help students understand the value of recycling aluminum. The students will explore the monetary value of aluminum beverage cans as a scrap metal and then consider the advantages of recycling aluminum in terms of reductions in energy consumption.

OBJECTIVES

THE STUDENTS WILL:

- ✓ Collect aluminum beverage containers for a given period of time (one week is suggested) and then *estimate* the total weight of the cans collected.
- ✓ Calculate the estimated value of the aluminum cans recovered.
- ✓ Explore the steps involved in producing aluminum beverage cans from raw materials.
- ✓ Explore the steps involved in producing aluminum beverage cans from recovered containers (recycled).
- ✓ Consider the energy and other environmental concerns related to producing aluminum beverage containers from raw materials versus recycled cans.

MATERIALS

- Appropriate container to hold the aluminum soda cans collected (a cardboard box lined with a trash bags works well).
- A small bucket or similar container (large coffee can) that can be used to transfer a sample portion of the cans collected.
- A scale to weigh a sample of collected cans.

Note: A laboratory scale is preferred and can often be borrowed from the school secondary science department. Alternatively a bathroom scale or inexpensive postal scale can be used with less accurate results.

- Classroom handouts diagramming the steps involved in producing an aluminum beverage can from raw materials versus recycled cans.

BACKGROUND

There are some obvious benefits in recycling materials. In some cases the raw materials are expensive to obtain, creating a financial incentive to recover materials after use. Additionally, landfill space is becoming increasingly difficult and expensive to obtain. The total volume of trash can be reduced by recycling a portion of the materials thrown away.

Other advantages of recycling are less obvious. Recycling helps to reduce the rate of natural resource use, as well as the impacts often associated with mining and processing raw materials. A significant amount of energy is required to produce the materials we use today and can be reduced by using recycling materials.

The process of recycling consists of several steps:

- ✓ Collection
- ✓ Separation
- ✓ Processing
- ✓ Remanufacturing
- ✓ Marketing

A material is not truly considered recycled until all of these steps are completed and the "recycling loop" is closed.

Aluminum beverage cans are a product that is commonly recycled. Aluminum is a silvery metal that is light, strong and resistant to corrosion. Aluminum is used in many applications ranging from airplanes to soda cans. Used beverage cans in particular are easy to recycle without a great deal of expensive processing.

Aluminum is produced from a mineral ore deposit called bauxite. Bauxite is found throughout the world with the greatest deposits located in tropical and sub-tropical areas of Africa, West Indies, South America and Australia. The bauxite ore is refined into aluminum oxide trihydrate (alumina) and then an electrical current (electrolysis) is used to reduce the alumina into metallic aluminum. This last process is very energy intensive. The bauxite is often shipped for smelting to locations where there is abundant supplies of inexpensive electricity, commonly in the form of hydroelectric power. The energy required to process aluminum from raw materials can be significantly reduced by using recycled products already composed of metallic aluminum.

Recycling one pound of aluminum reduces the energy associated with mining 8 pounds of bauxite, the energy associated with transporting the ore to a smelter and saves more than 14 kilowatt hours of electricity.

In addition to saving energy there are other impacts that can be reduced by recycling aluminum. Many of the tropical rainforests where bauxite is mined are unique habitats and support a concentrated diversity of plants and animals. Mining of bauxite produces solid waste, impacts water systems, and generates air pollution and other hazardous wastes. Also, by reducing the electrical power required to produce aluminum products, the environmental impacts associated with the production of electricity can be reduced.

PROCEDURE

WARM UP

Set the stage by asking the students:

- *What are some reasons to recycle used aluminum beverage cans?*
- *How many cans does it take to make a pound of aluminum?*
- *How much is a pound of aluminum worth?*
- *Where does aluminum come from?*

Part I

Have the students collect aluminum beverage cans for one week (longer if required to achieve a sufficient volume of cans). If your school has recycling program simply obtain the cans collected during a week.

Note: If cans are to be collected from home be sure to instruct the students only to collect non-alcoholic beverage containers…No beer cans in the school!!

The students will be handling the collected cans, so it's a good idea to instruct the students to rinse the cans prior to bringing into the classroom.

The students should crush the cans before adding them to the collection to reduce their bulk and make weighing the cans easier.

At the end of the collection period the students will need to determine the weight and number of the cans collected (in pounds).

Ask the students how they would determine the weight and number of the cans collected?

Calibration of the transfer bucket

First the students will need to calibrate the transfer bucket to be used to estimate the weight of the cans collected.

Have the students fill the bucket with crushed cans while counting the number of cans required to fill the bucket. Next the students should determine the weight of the bucket full of crushed cans. Following this step have the students empty the container back into the collection of cans and then determine the weight of the bucket without any cans inside. The students can now determine the actual weight of transfer bucket's worth of cans as shown below:

Weight of bucket with cans
- Weight of bucket empty
Weight of cans per bucket

This value should be written on the board along with the number of crushed cans that went into a full measuring bucket.

The students are now ready to estimate the total number of cans they have collected and the total weight of the cans collected. To do this, have the student's transfer the week's worth of crushed collected cans into another container using your now fully "calibrated" transfer bucket. The students should count the number of buckets worth of cans collected.

Estimating the weight and number of aluminum cans collected

An estimate of the total weight of collected cans can be determined by multiplying the number of buckets of crushed cans transferred by the weight of one calibrated bucket's full (determined previously).

An estimate of the total number of cans collected can be determined by multiplying the number of buckets transferred by the number of crushed cans determined per transfer bucket.

Ask the students what they think the cans they collected are worth as recovered scrap aluminum.

Assuming that aluminum cans are currently worth an average of 50 cents per pound, ask the students to calculate the value of the cans collected.

Have the class estimate how many pounds of aluminum they might collect in 1 year. What would the value of this amount be?

Part II

PRODUCTION OF ALUMINUM FROM RAW MATERIALS

Review with the class the diagram showing the steps involved in generating an aluminum beverage can from raw materials

In order to produce a ton (2,000 pounds) of aluminum from raw materials the following are required:

8766 pounds of bauxite
1020 pounds of petroleum coke
966 pounds of soda ash
327 pounds of pitch
238 pounds of lime
197 million BTU's of energy (85 percent in the form of electricity, 5-15 Kilowatt-hours per pound of aluminum produced from alumina)

Pollutants are produced during the production of aluminum from raw materials. The production of a ton (2,000 pounds) of aluminum from raw materials results in:

3,290 pounds of red mud
2,900 pounds of carbon dioxide
81 pounds of air pollutants
789 pounds of solid wastes

PRODUCTION OF ALUMINUM FROM RECYCLED CANS

Review with the class the diagram showing the steps involved in generating an aluminum beverage can from recycled material.

- ✓ Ask the class to consider the steps requiring energy when producing aluminum beverage can?
- ✓ What energy related steps are reduced by using recycled material?

It is estimated that 95 percent less energy is required to produce aluminum beverage cans from recycled cans as compared to production from bauxite.

- ✓ Ask the students to consider the environmental impacts associated with each step in creating an aluminum can.
- ✓ What impacts are reduced by using recycled cans.
- ✓ The students can be asked to calculate how many pounds of the raw materials would have been required to produce the volume of cans the students collected.

EXTENSIONS

The cost of manual labor involved in sorting recyclable products from raw trash often makes recycling material unprofitable. Have the students generate a survey to determine if local citizens (parents) would be willing to make an effort to sort recyclable materials at home before they end up in their personal trash (tin cans, plastic containers, aluminum cans, etc.) Have the students look into the possibility of establishing a curb-side recycling program or major drop off locations in their community. If these exist, have the students discuss how they can increase awareness of these programs.

GOING FURTHER

Discuss the benefits of recycling in terms of landfill space, energy involved in trash pickup and hauling.